The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

7-5.6 Distinguish between acids and bases and use indicators (including litmus paper, pH paper, and phenolphthalein) to determine their relative pH.
Taxonomy level: 4.1-B Analyze Conceptual Knowledge

Previous/Future knowledge: In 5th grade (5-4.5), students explained how the solute and the solvent in a solution determine the concentration. Students have not been introduced to the concept of solutions of acids and bases nor their concentrations in previous grades. They will further develop these concepts of acids and bases in high school Physical Science (PS-3.8).

It is essential for students to know that substances can be classified as acids, bases or neutral based on their pH. Acids and bases are solutions usually with water as the solvent.

pH

- The *pH scale* is a way to measure how acidic or basic a solution is.
- The pH range of a solution is between 0 and 14.
- The pH of pure water is 7. Any solution with a pH of 7 is *neutral solution*. It is not an acid or a base.
- The pH of an acidic solution is less than 7; the lower the number, the more acidic the solution.
- The pH of a basic solution is greater than 7; the higher the number, the more basic the solution.

Acid

- Acids can be identified by their sour taste (for example lemons and oranges contain acids); by their reaction with some metals such as zinc, and by their reaction with bases to form a neutral pH solution (for example, vinegar reacting with limestone).

Base

- *Bases* can be identified by their bitter taste (for example, unsweetened cocoa has a bitter taste); by its slippery feel (for example, dish detergent) and by its reaction with acids to form a neutral pH solution (for example, an antacid to soothe an acid stomach).

Neutral Solution

- It is neither an acid nor a base.
- For example, pure water is a neutral solution and has a pH of 7.

NOTE TO TEACHER: Students should not use a taste test on laboratory chemicals. Touching an unknown substance to observe if it feels slippery should not be done on laboratory chemicals as some strong bases burn the skin when touched.

It is essential for students to know how to use indicators (including litmus paper, phenolphthalein, and pH paper) to determine the relative pH of a solution. *Indicators* are substances that can be used to determine whether a solution is acidic, basic, or neutral.

Litmus paper
- Has a special dye on it that changes colors in the presence of an acid or base.
- Blue litmus paper turns red in an acid, and stays blue in a base.
- Red litmus paper turns blue in a base, and stays red in an acid.
- Both red and blue litmus paper turn violet in a solution that is neutral (neither an acid nor a base).

NOTE TO TEACHER: Students need to know the indicator colors for litmus paper.

Phenolphthalein
- Is used to test for the presence of a base.
- It is a colorless chemical that turns magenta (bright pink) in a base, and stays colorless in neutral or acidic solutions.

NOTE TO TEACHER: Students need to know the indicator colors (magenta for base or colorless) for phenolphthalein.

pH paper
- Has a range of colors depending on the pH of the solution.
- The color of the paper is compared to the chart on the vial to determine the pH.

It is not essential for students to know the specific colors of pH paper at given pH ranges as indicated on the chart on the vial; how to perform a neutralization of a solution to form water and salt; or how to use other indicators to determine the pH of a solution (such as purple/red cabbage juice and pH meters).

Assessment Guidelines:
One objective of this indicator is to *distinguish* between acids and bases; therefore, the primary focus of assessment should be to analyze properties of solutions to determine whether they are acids or bases. However, appropriate assessments should also require students to *identify* a solution as acidic or basic given its properties; *recall* the pH range associated with acidic, basic, and neutral solutions; *exemplify* substances that are acids or bases; *classify* a substance as an acid or base given its pH or description; or *summarize* the differences between acids and bases.

Another objective of this indicator is to *use* pH indicators to determine relative pH; therefore, the primary focus of assessment should be to apply a procedure that uses pH indicators to determine the relative acidic or basic properties of different solutions. However, appropriate assessments should also require students to *infer* the pH of a solution given the results of a particular indicator; *compare* solutions to determine which is more acidic, more basic, or neutral depending on the pH results; or *summarize* the use of indicators in determining the pH of a solution.